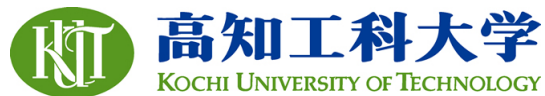


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# A Study of the Foehn Phenomenon Induced by Typhoon in Taiwan

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**ABSTRACT:** There're 171 typhoons making landfall all over Taiwan during the period (1960~2009), the research is on the basis of all weather stations belonging to Central Weather Bureau (CWB) records, and it has been found that there're 123 typhoons at least ever inducing Foehn wind event in one weather station in that area, the tract frequencies were around 71.9%. Among them, the total number of the class 2 tract is 24 for 19.5% of the total, the 1<sup>st</sup>, the total number of the class 5 tract is 22 for 17.9% of the total, the 2<sup>nd</sup>, the total number of the class 3 tract is 19 for 15.5% of the total, the 3<sup>rd</sup>.

There're 59 foehn phenomena induced by typhoon affecting Taiwan in the eastern Taiwan area, when the center of the class 1 typhoon tract was placed among the area ranged from 120° E to 124° E, 25° N to 28° N, would induce obvious foehn phenomena in Taitung, Dawu district in the eastern Taiwan. There're 110 foehn phenomena induced by typhoon affecting Taiwan in the western Taiwan area. When the center of the class 5 typhoon tract was placed among the area ranged from 123° E to 126° E, 17° N to 20° N and 19° N to 22° N, 119° E to 123° E, would induce foehn phenomena in Taichung, Hsinchu, Taipei district in the western Taiwan area.

**KEYWORDS:** the Foehn phenomenon

## 1. INTRODUCTION

Foehn the name comes from the Latin word for favonius, is a warm, dry down slope wind on the lee side of a mountain range in Alps. Foehn is a common weather phenomenon in all mountain areas, and has a lot of local names all over the world( such as Chinook: Rocky Mountains, Zonda: Argentina, Puelche: Andes mountains, North-wester: Czech Republic, Santa Ana: South California, Berg wind: South Africa, Canterbury Northwester: New Zealand...etc.(,1989)

When Foehn occurs, the temperature, moisture, and wind field often change severely. The foehn occurred on 1963-05-26, in Obinero, Japan. The wind speed increased from 2 m/s to 15m/s suddenly, when foehn occurred, the wind direction

changed from East wind to West-northwest wind, during the foehn lasting period, the wind direction maintained West-northwest wind, the temperature increased by 10° C in one hour, and increased by 21° C continually, the relative moisture decreased by 50% in 30 minutes (Arakawa, 1969).

The high-temperature and low-moisture status caused by the foehn would bring changes great injury to crops. Generally speaking, The temperature of the foehn wind changes more smoothly than the moisture change, the moisture drops rapidly will let the evaporation of the plant increase severely, furthermore, the temperature rises and the wind speed increases would cause the plant dehydrate rapidly and become withered, If the

lasting time elongates, the damage degree will become more severe (Kuo and Young, 1982). For example, the Foehn induced by typhoon “Ike” on 1981 in Yilan made several thousand hectares of rice field “whitened” and plundered over NT\$100 million from the farmer. According to the statistical data from the Agricultural Department, Taitung County Government showed that, The Foehn induced by typhoon “Sinlaku” (2008) caused serious damage to Shakya, Jin Zhen, Tea Garden, Rice all over Taitung, the Central Government provided allowance NT\$128 million for agricultural area around 5,386 hectares in Taitung County.

## 2. METHODOLOGY

The data of this study is obtained from the historical record dataset of the CWB and Data Bank for Atmospheric Research (DBAR), doing statistics and analyzing the relationship between the strength of the typhoon and Foehn Phenomena induced by typhoon over the past 50 years, filter the data ( $T - T_d \geq 9^\circ \text{C}$ , or  $T \geq 34^\circ \text{C}$ ) in Excel, and label the center of typhoon with the program (Fortran), and by statistics and analyze to generate different kind of chars.

2.1 The definition of the foehn phenomena in this study : According to the foehn phenomena forecast brief introduction of Taiwan typhoon analysis and forecast aid from CWB the definition of the obvious foehn phenomenon is : 「the highest temperature  $\geq 34^\circ \text{C}$ , and Depression of the dew point  $\geq 10^\circ \text{C}$ .」 Besides, the statistical data from CWB showed that: mean annual temperature is  $27^\circ \text{C}$ , the highest mean annual temperature is  $30^\circ \text{C}$ , the mean annual relative moisture is 80%. Therefore, from a disaster prevention point of view, to

consider the frequency of foehn phenomena in Taiwan district, we tried to analyze the foehn by it's strength, and took into account the characteristics of foehn temperature and moisture, The CWB classifies and defines the foehn as below: 1) the Depression of the dew point ( $T - T_d$ ) of observation station  $\geq 9^\circ \text{C}$ , the actual mean temperature  $\geq 32^\circ \text{C}$ , and mean relative moisture  $\leq 60\%$ . 2) the temperature of the observation station  $\geq 34^\circ \text{C}$ .

2.2 The relationship between the strength of the typhoon, the typhoon tract, and foehn phenomenon induced by typhoon:

On the basis of the data from the Typhoon database of the CWB, Doing statistics and analyzing the relationship between the strength, the Typhoon tract, and foehn phenomena induced by typhoon over the past 50 years has been found as below:

1) The research shows that there're 123 typhoons affecting Taiwan inducing foehn events all over Taiwan during the period (1960-2009) for 71.9% of the total of the foehn events, they're all inducing 484 foehn phenomena in 13 weather stations all over Taiwan. Among them, the amount in eastern area was 112 for 23% of the total, the amount in western area was 372 for 77% of the total (Figure 1). For the strength of typhoon, the amount of Medium-Strength typhoon was 219 for 45% of the total, the 1<sup>st</sup>, The amount of weak typhoon was 124 for 26% of the total, the 2<sup>nd</sup>, The amount of strong typhoon was 121 for 25% of the total, the 3<sup>rd</sup>, The amount of tropical cyclone was 20 for 4%, the 4<sup>th</sup> (Figure 2). For the typhoon tract, the amount of the class 5 tract was 124 for 25.6% of the total, the 1<sup>st</sup>, the amount of the class 3 tract was 69 for 14.2% of the total, the 2<sup>nd</sup>, the amount of the class 2 and 6 was 65 for 13.4%, the 3<sup>rd</sup> (Figure 3).

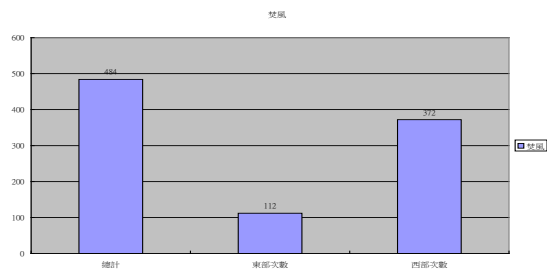


Figure 1 484 foehn phenomena in 13 weather stations all over Taiwan.

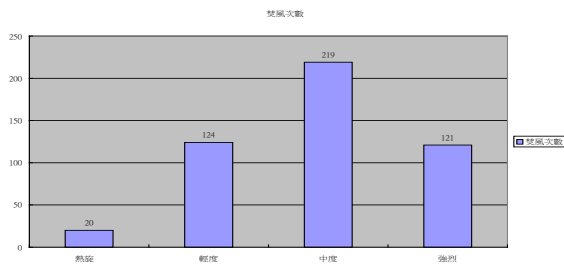


Figure 2 The strength of the typhoon that inducing foehn events all over Taiwan during the period (1960-2009)



Figure 3 The relationship between the typhoon tracts and foehn phenomenon induced by typhoon

- The research shows that there're 59 typhoons affecting Taiwan inducing foehn events in the eastern Taiwan for 34.5% of the total of the foehn events, they're all inducing 112 foehn phenomena in 5 weather stations such as the Yilan weather station, among them, the total number of foehn events in Taitung weather

station was 49 for 44% of the total, the 1<sup>st</sup>, the total number of foehn events in Dawu and Cheng Gong weather station was 18 for 16% of the total, the 2<sup>nd</sup>, the total number of foehn events in Hualien weather station was 16 for 14% of the total, the 3<sup>rd</sup>, the total number in Yilan weather station was 11 for 10% of the total, the 4<sup>th</sup> (Figure 4). For the strength of typhoon, the amount of Medium-Strength typhoon was 60 for 54% of the total, the 1<sup>st</sup>, the amount of strong typhoon is 32 for 28% of the total, the 2<sup>nd</sup>, the amount of weak typhoon is 17 for 15% of the total, the 3<sup>rd</sup>, the amount of tropical cyclone is 3 for 3% of the total, the 4<sup>th</sup> (Figure 5). For the typhoon tract, the amount of the class 1 tract is 34 for 30% of the total, the 1<sup>st</sup>, the amount of the class 2 tract is 24 for 21% of the total, the 2<sup>nd</sup>, the amount of the class 3 and 5 tract is 14 for 13% of the total, the 3<sup>rd</sup> (Figure 6).

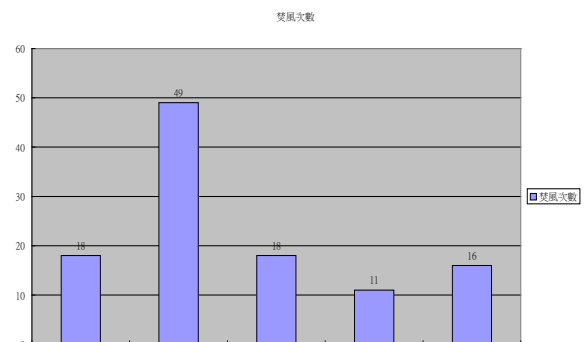


Figure 4 112 foehn phenomena in the eastern Taiwan

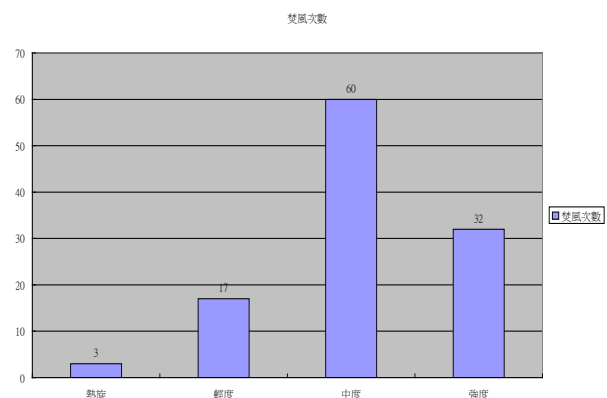


Figure 5 The strength of the typhoon in the eastern Taiwan.



Figure 6 The relationship between the typhoon tracts and foehn phenomenon induced by typhoon in the eastern Taiwan.

- 3) The research shows that there're 110 typhoons affecting Taiwan inducing foehn events in the western Taiwan for 64.3% of the total of the foehn events, they're all inducing 372 foehn phenomena in 8 weather stations such as the Taipei weather station, among them, the total number of foehn events in Taipei weather station was 111 for 30% of the total, the 1<sup>st</sup> of the total, the total number of foehn events in Taichung weather station was 73 for 20% of the total, the 2<sup>nd</sup>, the total number of foehn events in Hsinchu weather station was 67 for 18% of the total, the 3<sup>rd</sup> (Figure 7). For the strength of typhoon, the amount of Medium-Strength typhoon was 159 for 43% of the total, the 1<sup>st</sup>, the amount of weak typhoon is 107 for 29% of the total, the 2<sup>nd</sup>, the amount of strong typhoon is 89 for 24% of the total, the 3<sup>rd</sup> (Figure 8). For the typhoon tract, the amount of the class 5 tract is 110 for 30% of the total, the 1<sup>st</sup>, the amount of the class 6 tract is 56 for 15% of the total, the 2<sup>nd</sup>, the amount of the class 3 tract is 55 for 15% of the total, the 3<sup>rd</sup> (Figure 9).

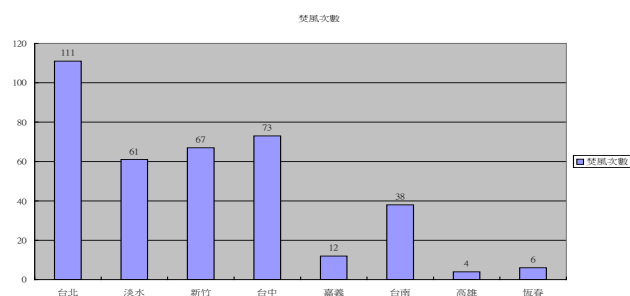


Figure 7 372 foehn phenomena in the western Taiwan

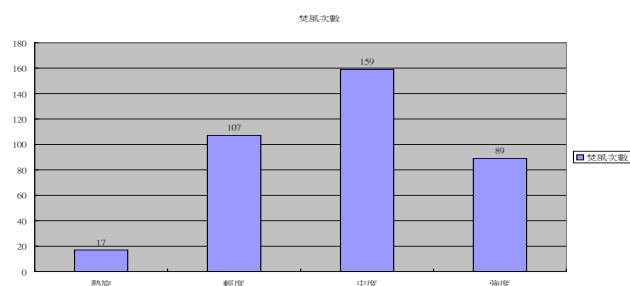


Figure 8 The strength of the typhoon in the western Taiwan.

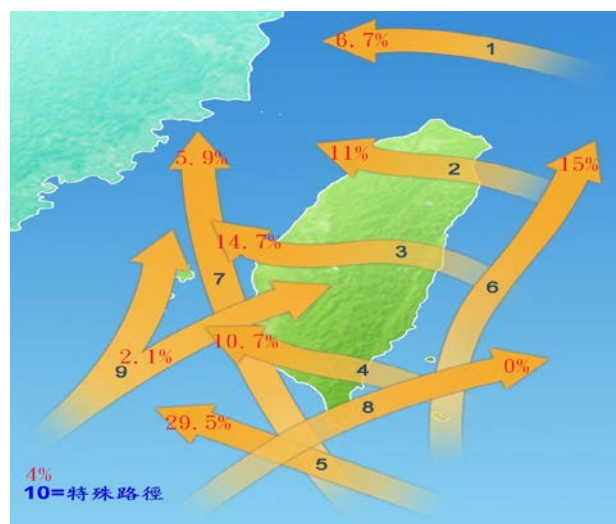


Figure 9 The relationship between the typhoon tracts and foehn phenomenon induced by typhoon in the western Taiwan.

- 4) The research shows that there're 46 typhoons affecting Taiwan inducing foehn events simultaneously in the western and eastern Taiwan for 26.9% of the total of the foehn events, they're all inducing 280 foehn phenomena in 13 weather stations in Taiwan, among them, the

total number of foehn events in Taipei weather station was 50 for 18% of the total, the 1<sup>st</sup>, the total number of foehn events in Hsinchu weather station was 39 for 14% of the total, the 2<sup>nd</sup>, the total number of foehn events in Taitung weather station was 37 for 13% of the total, the 3<sup>rd</sup>(Figure 10). For the strength of typhoon, the amount of Medium-Strength typhoon was 129 for 46% of the total , the 1<sup>st</sup>, the amount of strong typhoon is 88 for 32% of the total, the 2<sup>nd</sup>, the amount of weak typhoon is 51 for 18% of the total, the 3<sup>rd</sup>, The amount of tropical cyclone was 12 for 4% of the total, the 4<sup>th</sup>(Figure 11). For the typhoon tract, the amount of the class 5 tract is 69 for 24.6% of the total, the 1<sup>st</sup>, the amount of the class 1 tract is 48 for 17.1% of the total, the 2<sup>nd</sup>, the amount of the class 3 tract is 46 for 16.4% of the total, the 3<sup>rd</sup> (Figure 12).

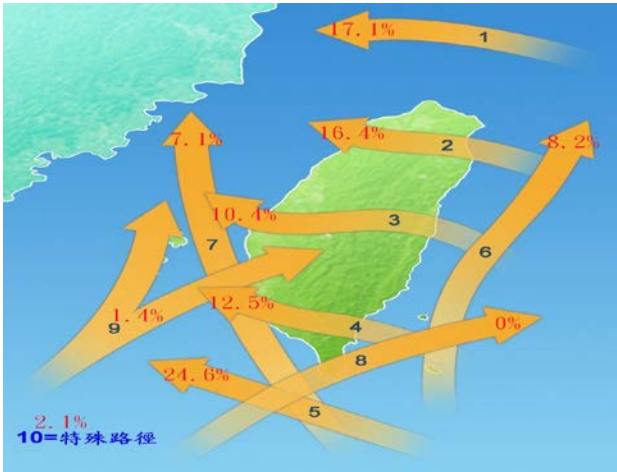


Figure 12 The relationship between the typhoon tracts and foehn phenomenon induced by typhoon in the eastern and western Taiwan.

### 2.3 The relationship between the central location of the typhoon and the typhoon induced foehn events:

#### 2.3.1 Classified by typhoon track, and demarcated by Central Mountain Range, In eastern district:

1) The class 1 typhoon affecting Taiwan track: when the centers of these typhoons were placed among the area ranged from 120° E to 124° E, 25° N to 28° N, would induce the most obvious foehn phenomena in the eastern Taiwan (Figure 13). According to the statistics: the class 1 typhoon affecting Taiwan track induced 200hour foehn phenomena in eastern Taiwan, among them, the foehn lasting time in Taitung was up to 94 hours , the 1<sup>st</sup>, and the foehn lasting time in Dawu was up to 55 hours, the 2<sup>nd</sup>, and caused high temperature(38.3 ° C) and the lowest relative humidity (30%) in Taitung.

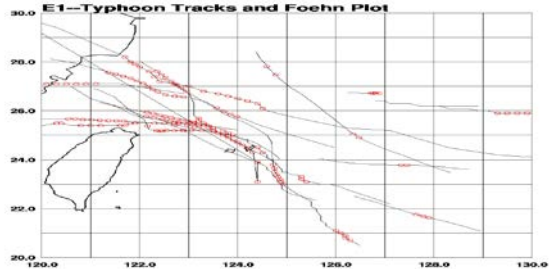


Figure 13 The relationship between the central location of the class 1 typhoon track and the typhoon induced foehn events in the eastern Taiwan.

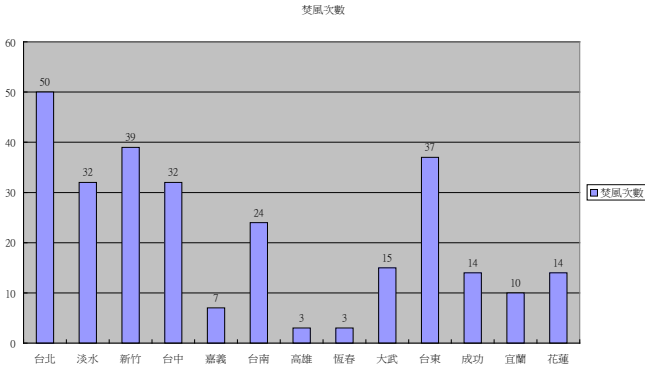


Figure 10 280 foehn phenomena in the eastern and western Taiwan.

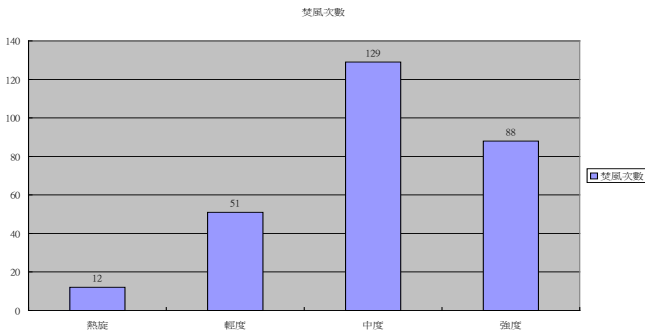


Figure 11 The strength of the typhoon in the eastern and western Taiwan.

2) The class 2 typhoon affecting Taiwan track: when the centers of these typhoons were placed among the area ranged from 121° E to 124° E, 24° N to 25° N, would induce the more obvious foehn phenomena in the eastern Taiwan (Figure 14). According to the statistics: the class 2 typhoon affecting Taiwan tract induced 93hour foehn phenomena in eastern Taiwan, among them, the foehn lasting time in Taitung was up to 52 hours , the 1<sup>st</sup>, and the foehn lasting time in Cheng Gong was up to 22 hours, the 2<sup>nd</sup>, and caused the high temperature (37.6°C) and the relative humidity (37%) in Taitung, the high temperature(37°C) and the lowest relative humidity (33%) in Cheng Gong.

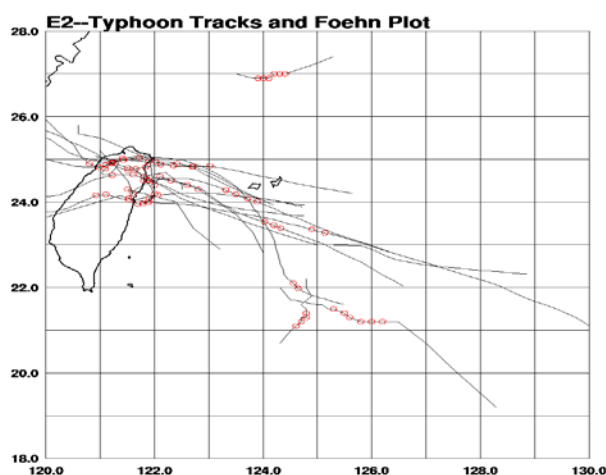


Figure 14 The relationship between the central location of the class 2 typhoon tract and the typhoon induced foehn events in the eastern Taiwan.

3) The class 3 typhoon affecting Taiwan tract: when the centers of these typhoons were placed among the area ranged from 121° E to 126° E, 21° N to 24° N, would induce the more obvious foehn phenomena in the eastern Taiwan. According to the statistics: the class 3 typhoon affecting taiwan tract induced 50hour foehn phenomena in eastern Taiwan, among them, the foehn lasting time in Taitung was up to 17 hours , the 1<sup>st</sup>, and the foehn

lasting time in Cheng Gong was up to 11 hours, the 2<sup>nd</sup>, and caused the high temperature (36.9 °C) and the relative humidity (35%) in Taitung; the high temperature (37°C) and the lowest relative humidity (39%) in Cheng Gong.

4) The class 4 typhoon affecting Taiwan track: when the centers of these typhoons were placed among the area ranged from 123° E to 127° E, 20° N to 22° N, would induce the more obvious foehn phenomena in the eastern Taiwan. According to the statistics: the class 4 typhoon affecting taiwan tract induced 34hour foehn phenomena in eastern taiwan, among them, the foehn lasting time in Taichung was up to 13 hours , the 1<sup>st</sup>, and the foehn lasting time in Hualien was up to 12 hours, the 2<sup>nd</sup>, and caused the high temperature (34.2°C) and the relative humidity (59%) in Hualien.

5) The class 5 typhoon affecting Taiwan track: when the centers of these typhoons were placed among the area ranged from 122° E to 125° E, 18° N to 21° N, would induce the more obvious foehn phenomena in the eastern Taiwan. According to the statistics: the class 5 typhoon affecting taiwan tract induced 42hour foehn phenomena in the eastern Taiwan, among them, the foehn lasting time in Taitung was up to 27 hours , the most, and the foehn phenomena in the other weather station didn't last more than 10 hours, and caused the high temperature (35.8°C) and the lowest relative humidity (54%) in Taitung.

6) The class 6 typhoon affecting Taiwan track: when the centers of these typhoons were placed among the area ranged from 122° E to 125° E, 24° N to 27° N, would induce the more obvious foehn phenomena in the eastern Taiwan. According to the statistics: the class 6 typhoon affecting taiwan tract induced 44hour foehn phenomena in the



eastern Taiwan, among them, the foehn lasting time in Taichung was up to 30 hours , the most, and the foehn phenomena in the other weather station didn't last more than 10 hours, and caused the high temperature (38 °C ) and the lowest relative humidity (31%) in Cheng Gong, the high temperature (36.9 °C ) and the lowest relative humidity(34%) in Taitung.

- 7) The class 7 typhoon affecting Taiwan track: the foehn phenomena only lasted 2 hours in Taitung and Hualien respectively, and caused the high temperature (34 °C ) and the lowest relative humidity (59%) in Taitung.
- 8) The class 8 typhoon affecting Taiwan track: No foehn phenomena.
- 9) The class 9 typhoon affecting Taiwan track: the foehn phenomena lasted 2 hours in Taitung and 4 hours in Dawu, and caused the high temperature (35°C) and the lowest relative humidity (53%) in Dawu.
- 10) The class 10 typhoon affecting Taiwan track: only inducing 8 hours foehn phenomena in Dawu, 6 hours foehn phenomena in Taitung, 4 hours foehn phenomena in Yilan, and caused the high temperature (34.5 °C ) and the lowest relative humidity (31%) in Taitung.

### 2.3.2 Classified by typhoon track, and demarcated by Central Mountain Range, in the western district:

- 1) The class 1 typhoon affecting Taiwan track: when the centers of these typhoons were placed among the area ranged from 126° E to 128° E, 20° N to 24° N, would induce obvious foehn phenomena in the western Taiwan. According to the statistics: the class 1 typhoon affecting Taiwan tract induced 97 hours foehn phenomena in western Taiwan,

among them, the foehn lasting time in Taipei was up to 32 hours , the 1<sup>st</sup>, and the foehn lasting time in Taichung was up to 25 hours, the 2<sup>nd</sup>, and caused high temperature (36.4°C) and the lowest relative humidity (41%) in Hsinchu.

- 2) The class 2 typhoon affecting Taiwan track: when the centers of these typhoons were placed among the area ranged from 124° E to 130° E, 19° N to 23° N, would induce the more obvious foehn phenomena in the western Taiwan. According to the statistics: the class 2 typhoon affecting Taiwan tract induced 160 hours foehn phenomena in western Taiwan, among them, the foehn lasting time in Taipei was up to 61 hours , the 1<sup>st</sup>, and the foehn lasting time in Danshui was up to 30 hours, the 2<sup>nd</sup>, and caused the high temperature (36°C) and the lowest relative humidity (42%) in Taipei, the high temperature (36 °C ) and the lowest relative humidity (52%) in Hsinchu.
- 3) The class 3 typhoon affecting Taiwan track: when the centers of these typhoons were placed among the area ranged from 123° E to 127° E, 17° N to 20° N, and from 121° E to 125° E, 21° N to 24° N would induce the more obvious foehn phenomena in the western Taiwan. According to the statistics: the class 3 typhoon affecting taiwan tract induced 252 hours foehn phenomena in western Taiwan, among them, the foehn lasting time in Taipei was up to 93 hours , the 1<sup>st</sup>, the foehn lasting time in Danshui was up to 57 hours, the 2<sup>nd</sup>, the foehn lasting time in Hsinchu was up to 41 hours, the 3<sup>rd</sup>, and caused the high temperature (36.6°C) and the relative humidity (55%) in Danshui, the high temperature (36.4 °C ) and the lowest relative humidity (44%) in Hsinchu.
- 4) The class 4 typhoon affecting Taiwan track: when the centers of these typhoons were placed among



the area ranged from 121° E to 126° E, 19° N to 24° N, would induce the more obvious foehn phenomena in the western Taiwan. According to the statistics: the class 4 typhoon affecting Taiwan track induced 158 hours foehn phenomena in western Taiwan, among them, the foehn lasting time in Taipei was up to 46 hours, the 1<sup>st</sup>, and the foehn lasting time in Taichung was up to 33 hours, the 2<sup>nd</sup>, and caused the high temperature (36.5°C) and the lowest relative humidity(49%) in Taipei.

5) The class 5 typhoon affecting Taiwan track: when the centers of these typhoons were placed among the area ranged from 123° E to 126° E, 17° N to 20° N, and from 119° E to 123° E, 19° N to 22° N would induce the more obvious foehn phenomena in the western Taiwan (Figure 15). According to the statistics: the class 5 typhoon affecting Taiwan track induced 539 hours foehn phenomena in western Taiwan, among them, the foehn lasting time in Taipei was up to 162 hours, the 1<sup>st</sup>, and the foehn lasting time in Hsinchu was up to 122 hours, the 2<sup>nd</sup>, the foehn lasting time in Taichung was up to 115 hours, the 3<sup>rd</sup>, and caused the high temperature (38.2°C) and the lowest relative humidity (41%) in Danshui; the high temperature (38.7°C) and the lowest relative humidity (40%) in Taichung.

6) The class 6 typhoon affecting Taiwan track: when the centers of these typhoons were placed among the area ranged from 124° E to 128° E, 16° N to 19° N, and 121° E to 125° E, 19° N to 23° N would induce the more obvious foehn phenomena in the western Taiwan (Figure 16). According to the statistics: the class 6 typhoon affecting Taiwan track induced 253hour foehn phenomena in the western Taiwan, among them, the foehn lasting time in Taipei was up to 82 hours, the 1<sup>st</sup>, and the foehn lasting time in Hsinchu was up to 61 hours, the 2<sup>nd</sup>, the foehn lasting time in Danshui was up to 44 hours, the 3<sup>rd</sup>, and caused the high

temperature (39.7°C) and the lowest relative humidity (33%) in Taichung, the high temperature (36.4°C) and the lowest relative humidity (50%) in Hsinchu.

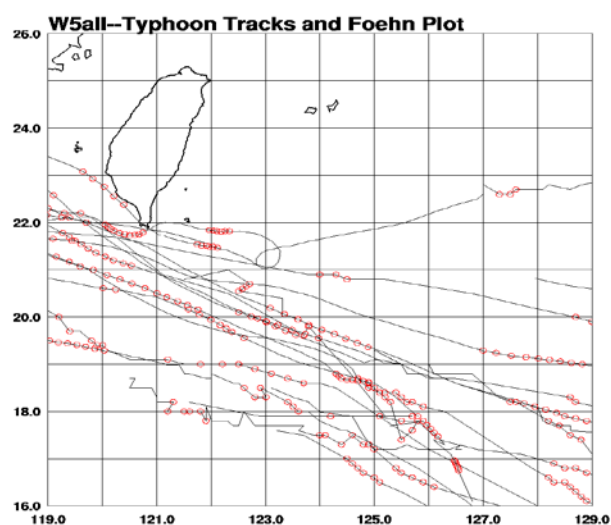


Figure 15 The relationship between the central location of the class 5 typhoon track and the typhoon induced foehn events in the western Taiwan.

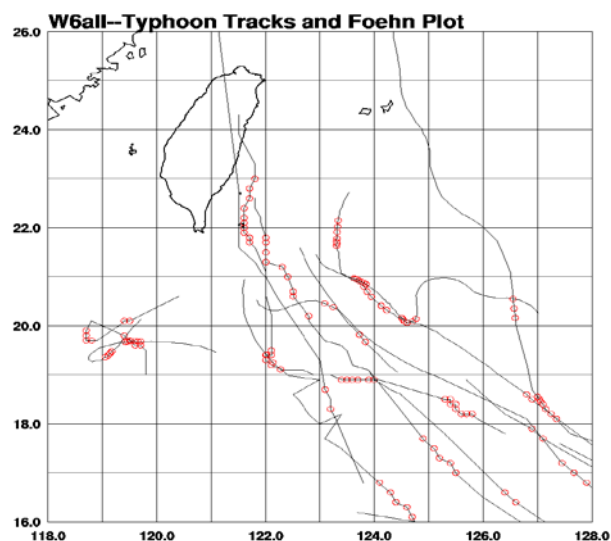


Figure 16 The relationship between the central location of the class 6 typhoon track and the typhoon induced foehn events in the western Taiwan.

7) The class 7 typhoon affecting Taiwan track: the foehn phenomena only lasted 32 hours in Danshui, the foehn phenomena in the other weather station

didn't last more than 30 hours and caused the high temperature(36.3 °C ) and the lowest relative humidity(35%) in Taitung.

- 8) The class 8 typhoon affecting Taiwan track: no foehn phenomena.
- 9) The class 9 typhoon affecting Taiwan track: the foehn phenomena didn't occur in Danshui, Hsinchu, Taichung, Chiayi, Hengchun, and the foehn phenomena didn't last more than 20 hours in the other weather station.
- 10) The class 10 typhoon affecting Taiwan track: the foehn phenomena didn't occur in Chiayi, Tainan, Kaohsiung and the foehn phenomena didn't last more than 30 hours in the other weather station.

2.3.3 The central locations of the typhoon, which induced foehn wind could be classified according to the weather stations belong to C.W.B.:

- 1) The Taitung weather station: when the centers of class 1 and 2 typhoon affecting Taiwan were placed among the area ranged from 121° E to 125° E, 24° N to 28° N, would induce the more obvious foehn phenomena in the Taitung district. (Figure17). The typhoon FRED(1994) induced the foehn phenomena, and generated high temperature(38.3° C), the lowest relative humidity (30%) in Taitung weather station (14:00, 08/21/1994).

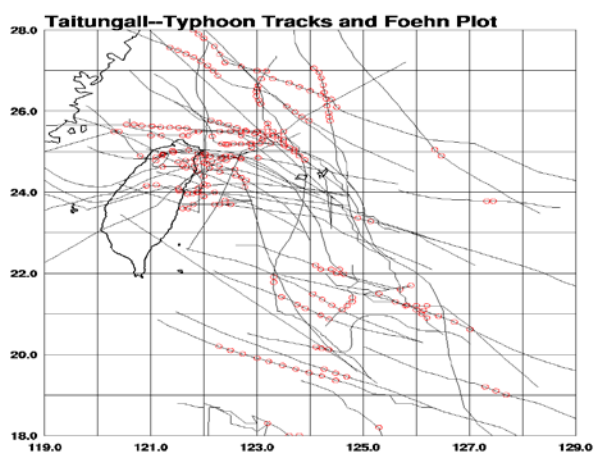


Figure 17 The relationship between the central location of the class 1&2 typhoon tract and the typhoon induced foehn events in the Taitung district.

- 2) The Dawu weather station: when the centers of class 4~6 typhoon affecting Taiwan were placed among the area ranged from 120° E to 125° E, 23° N to 28° N, would induce more obvious foehn phenomena in the Dawu district. The typhoon AERE(2004) induced the foehn phenomena, and generated high temperature (35.8° C), the lowest relative humidity (47%) in Dawu weather station (13:00~15:00, 08/23/2004).

- 3) The Cheng Gong weather station: when the centers of class 1~3 typhoon affecting Taiwan were placed among the area ranged from 121° E to 125° E, 23° N to 28° N, would induce obvious foehn phenomena in the Cheng Gong district.(Figure 18). The typhoon DOUG (1994) induced the foehn phenomena, and generated high temperature(38°C), the lowest relative humidity (31%) in Cheng Gong weather station (03:00,08/08/1994).

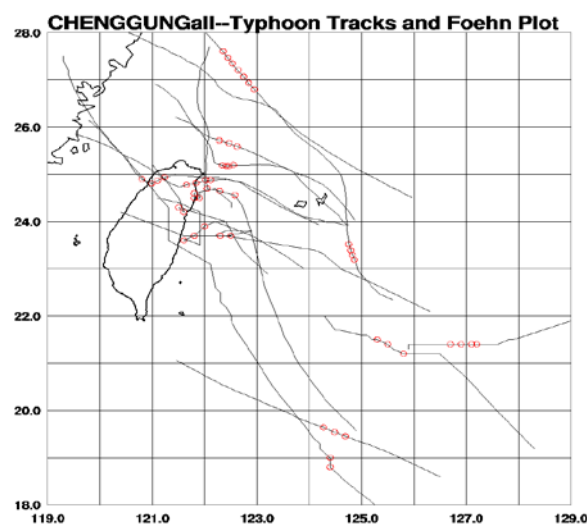


Figure 18 The relationship between the central location of the class 1~3 typhoon tracts and the typhoon induced foehn events in the Cheng Gong district.

- 4) The Taipei weather station: when the centers of class 3,5,6 typhoon affecting Taiwan were placed among the area ranged from 121° E to 129° E, 16° N to 23° N, would induce foehn phenomena in the Taipei district. The typhoon LUCY(1971) induced the

foehn phenomena, and generated high temperature (36.6° C), the lowest relative humidity (41%) in Taipei weather station (19/07/1971); high temperature (36.8°C), the lowest relative humidity (37%) in Taipei weather station (21/07/1971).

5) The Hsinchu weather station: when the centers of class 3,5,6 typhoon affecting Taiwan were placed among the area ranged from 120° E to 130° E, 16° N to 24° N, would induce foehn phenomena in the Hsinchu district. The typhoon MINDULLE(2004) induced the foehn phenomena, and generated high temperature (36.4° C), the lowest relative humidity (52%) in Hsinchu weather station(13:00, 30/06/2004).

6) The Taichung weather station: when the centers of class 1~10 typhoon affecting Taiwan were placed among the area ranged from 120° E to 130° E, 16° N to 24° N, would induce foehn phenomena in the Taichung district. (Figure19). The typhoon MINDULLE (2004) induced the foehn phenomena, and generated high temperature(39.7° C), the lowest relative humidity (33%) in Taichung weather station (15:00, 01/07/2004).

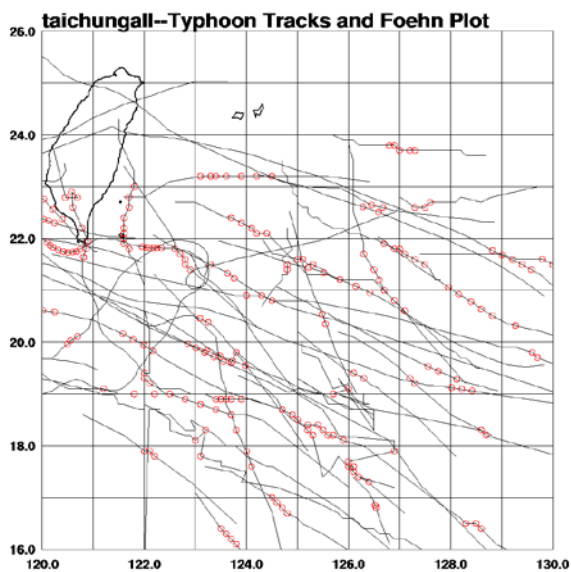


Figure 19 The relationship between the central location of the class 1~10 typhoon tracks and the typhoon induced foehn events in the Taichung district.

7) The Danshui weather station: when the centers of class 3,5 typhoon affecting Taiwan were placed among the area ranged from 120° E to 130° E, 16° N to 22° N, would induce obvious foehn phenomena in the Danshui district. (Figure 20). The typhoon WAYNE (1983) induced the foehn phenomena, and generated high temperature(38.2° C ), the lowest relative humidity (41%) in Danshui weather station (24/07/1983).

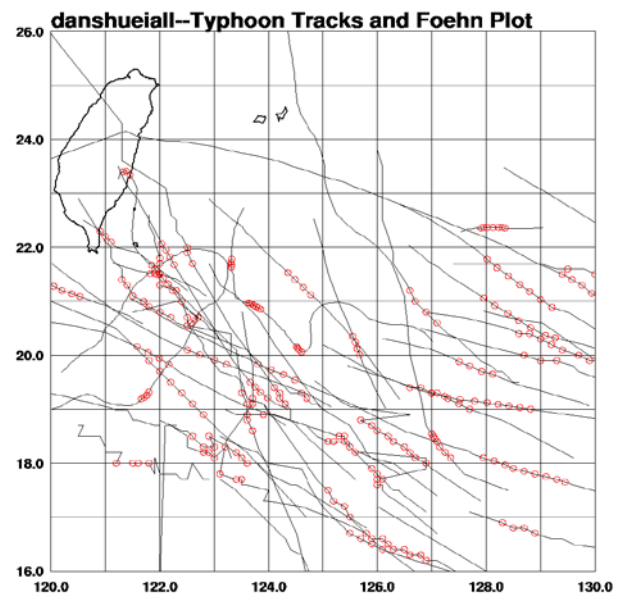


Figure 20 The relationship between the central location of the class 3 & 5 typhoon tracks and the typhoon induced foehn events in the Danshui district.

### 3. The foehn lasting time and occurring time

3.1. The Eastern weather station: there're 112 foehn phenomena induced by 59 typhoons in 5 weather stations such as Yilan station during the period(1960~2009), the total foehn lasting time is up to 483 hours, among them, the 243 hours foehn wind in Taitung weather station is for 50% of the total, the 1<sup>st</sup>, the 79 hours foehn wind in Dawu weather station for 16% of the total, the 2<sup>nd</sup>, the 64 hours foehn wind in Cheng Gong weather station for 13% of the total, the 3<sup>rd</sup>.

3.2. The Western weather station: there're 372 foehn phenomena induced by 110 typhoons in 8 weather stations such as Taipei station during the period(1960~2009), the total foehn lasting time is up to 1663 hours, among them, the 546 hours foehn wind in Taipei weather station is for 33% of the total, the 1<sup>st</sup>, the 311 hours foehn wind in Danshui weather station for 19% of the total, the 2<sup>nd</sup>, the 307 hours foehn wind in Hsinchu weather station for 18% of the total, the 3<sup>rd</sup>.

3.3. The foehn occurring time: the daily time interval is from 08:00 to 18:00, the nightly interval is from 19:00 to 07:00.

- 1) The eastern weather station: the total number of foehn events in Taitung weather station are up to 49 times, the 1<sup>st</sup>.(Among them, the daily foehn phenomena happened 38 times, the nightly foehn phenomena happened 11 times.) The total number of foehn events in Dawu and ChengGong weather stations are 18 times, the 2<sup>nd</sup>.(Among them, the daily foehn phenomena happened 15 times, the nightly foehn phenomena happened 3 times in Dawu weather station; the daily foehn phenomena happened 10 times, the nightly foehn phenomena happened 8 times in Cheng Gong weather station). The total number of foehn events in Hualien weather station are up to 16 times, the 3<sup>rd</sup>.(Among them, the daily foehn phenomena happened 15 times, the nightly foehn phenomena happened 1 times).
- 2) The western weather station: the total number of foehn events in Taipei weather station are up to 111 times, the 1<sup>st</sup>.(Among them, the daily foehn phenomena happened 111 times, the nightly foehn phenomena didn't occur.) The total number of foehn events in Taichung weather stations are 73 times, the 2<sup>nd</sup>.(Among them, the daily foehn phenomena happened 71 times, the nightly foehn phenomena happened 2 times in Taichung weather

station). The total number of foehn events in Hsinchu weather station are up to 67 times, the 3<sup>rd</sup>. (Among them, the daily foehn phenomena happened 63 times, the nightly foehn phenomena happened 4 times).

#### 4. Conclusion

Foehn is a common weather phenomenon in all mountain areas. That's because the typhoons blow strongly will induce foehn phenomena, become high-temperature, low-moisture status in larger area, last longer time, and bring great injury to crops. By the above statistical analysis, the conclusion of this study is as below:

##### 4.1 The relationship between the typhoon track and foehn phenomena induced by typhoon:

- 1) For all the Taiwan area, the percentage of the phenomenon phenomena induced by the class 5 typhoon tract is the highest, the second is the class 6 typhoon track.
- 2) The first three typhoon inducing foehn phenomena tracts in eastern district, in order, are class 6, 1, 5 typhoon tracks.
- 3) The first three typhoon inducing foehn phenomena tracts of in western district, in order, are class 5, 6, 3 typhoon tracks.
- 4) The first three typhoon inducing foehn phenomena tracts of in eastern and western districts at the same time, in order, are class 5,6,1 typhoon tracts.

##### 4.2 The statistics about the strength of typhoon and the foehn phenomena:

- 1) The first three strength of typhoons inducing foehn phenomena in eastern district, in order, are strong, medium-strength, weak typhoon.
- 2) The first three strength of typhoons inducing foehn phenomena in western district, in order, are

medium-strength, strong, weak typhoon.

- 3) The first three strength of typhoons inducing foehn phenomena in eastern and western districts at the same time, in order, are medium-strength, strong, weak typhoon.
- 4) The first three strength of typhoons inducing foehn phenomena all over Taiwan area, in order, are medium-strength, strong, weak typhoon.

#### 4.3 The foehn lasting time and occurring time

- 1) The total foehn phenomena lasting time in the eastern district is up to 483 hours, among them, the daily interval is 377 hours, the average is 4.2 hours/time; the nightly interval is 106 hours, the average is 4.6 hours/time.
- 2) The total foehn phenomena lasting time in the western district is up to 1,663 hours, among them, the daily interval is 1,638 hours, the average is 4.5 hours/time; the nightly interval is 25 hours, the average is 4.2 hours/time.
- 3) The total foehn phenomena lasting time is up to 1,262 hours, among them, the daily interval is 1171 hours, the average is 4.5 hours/time; the nightly interval is 91 hours, the average is 4.8 hours/time.
- 4) The total foehn phenomena lasting time is up to 2,146 hours, among them, the daily interval is 2,017 hours, the average is 4.4 hours/time; the nightly interval is 129 hours, the average is 4.4 hours/time.

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